REMARKS

The Examiner's attention to the present application is noted with appreciation, as is her allowance of claims 16-19.

The Examiner objected to the figures as informal. Formal drawings are submitted herewith.

The Examiner objected to claims 20 and 32 for informalities, which have been corrected by amendment, above. A typographical error in claim 19 has also been corrected.

The Examiner rejected claims 1, 2, 4-10, 33, 34, 37, and 38 under 35 U.S.C. § 102(b) as being anticipated by Lewandowski et al. ("Lewandowski"). The rejection is traversed, particularly as to the claims as amended, as discussed below.

The Examiner rejected claims 1-3, 5-10, and 30-38 under 35 U.S.C. § 102(b) as being anticipated by Nishimura et al. ("Nishimura"). The rejection is traversed, particularly as to the claims as amended, as discussed below.

The Examiner rejected claims 33-40 and 42 under 35 U.S.C. § 102(e) as being anticipated by Kindler et al. ("Kindler"). The rejection is traversed, particularly as to the claims as amended, as discussed below.

The Examiner rejected claims 3, 11-26, 35, 36, and 39-42 under 35 U.S.C. § 103(a) as being unpatentable over Lewandowski. The rejection is traversed, particularly as to the claims as amended, as discussed below.

The Examiner rejected claims 27-29 under 35 U.S.C. § 103(a) as being unpatentable over Askin in view of Lewandowski. The rejection is traversed, particularly as to the claims as amended, as discussed below.

The Examiner rejected claim 41 under 35 U.S.C. § 103(a) as being unpatentable over Kindler in view of Richart. The rejection is traversed, particularly as to the claims as amended, as next discussed.

As discussed by the Examiner, laser beam guidance of particles involves focusing a Gaussian laser beam and injecting particles into the beam. The particles are then guided by gradient and scattering forces. This sort of guidance is described in Ashkin and Nishimura. Similarly, particles can be guided through an optical conductor as broadly defined by the Examiner by directing the laser in one end and out the other end of the conductor. However, the laser beam is still essentially Gaussian in these configurations. It is assumed that the laser will not hit the walls of the conductor. Therefore in Ashkin and Nishimura, the laser profile is essentially the same whether or not the optical conductor as broadly defined is placed around the laser beam. The particles can be manipulated by either translating the laser beam or by pushing the particles along the beam with radiation or photophoretic forces.

Laser-particle guidance in optical fibers is distinct from the prior art and not obvious to one of ordinary skill in view of it.

First, it is well known that optical fibers are used to guide (transport) laser light over long distances. In doing so the laser light is launched into fiber so that it gets trapped in the high-refractive index region at the fiber core. The light propagates through the fiber by total internal reflection at the high-to-low refractive index interface. The laser profile inside the fiber is not Gaussian, but rather is described by various special functions that are solutions to the electromagnetic wave equation with cylindrical boundary conditions. This difference in profile has consequences to particle guidance, described below. Since the laser light is guided, the fiber can be bent, twisted, rolled up, etc. and the light is transported through the fiber. The same bending and twisting obviously can not be done to a free-space laser beam.

Second, hollow-core optical fibers are substantially different than normal, solid core fibers. Normal fibers have a high refractive-index region at the core, but hollow fibers have a low refractive-index region at the core (the hollow region is surrounded by glass or metal). Given the physical difference, it is not even readily apparent that hollow fibers should even function as a light guide except to those having a specialty in that area.

It is not straightforward to simultaneously guide light and guide particles. The main reason is that the way light is launched into the fiber is critical. When guiding light in a normal fiber optic, the light may be launched into a variety of possible optical fiber modes. The modes only need to satisfy conditions for total internal reflection. Similarly, light in hollow fibers may also be guided in several different modes. However, the situation is more complicated when it comes to simultaneous light and particle guidance. As mentioned, the transverse laser profile in hollow fibers (Bessel functions) is similar to normal fibers, but both are significantly different than free-space Gaussian modes. In order to guide a particle the laser profile must have high intensity near the center of the fiber, but the intensity must fall to nearly zero at the wall. If it does not fall to zero at the wall, the particle is likely to hit and stick because the gradient force is not substantial at the wall. One (and only one) hollow fiber mode has the necessary intensity profile. This is the lowest order mode, described by a J_0 Bessel function, as discussed in the specification at page 7, lines 2-23. All other modes are either non-zero at the wall, or have azimuthal intensity variations that allow particles to escape to the wall. Given this restriction on modes, it is not as straightforward to launch light into a hollow fiber as the Examiner suggests, citing Lewandowski, which does not mention this enabling detail. In particular great care must be taken to couple into the lowest order fiber mode. It requires that the exiting light be diagnosed for contamination from higher order modes. The coupling to these modes must be minimized. Accordingly, Applicants reassert that Lewandowski is non-enabling.

Third, the advantages of laser-fiber guidance are dramatic over laser guidance. Since the light is 'guided', the fiber can be bent and twisted and the light will follow these geometrical changes. In turn, the particles will follow the light path. Specifically related to surface patterning, the particles can be directed to different positions on the substrate by manipulating or bending the fiber. The prior art teaches particle manipulation only be translating the laser beam or the substrate. Therefore, the fiber gives a new and non-obvious capability.

Fourth, since the fiber guides the laser light over long distances, the particles now can also be guided over long distance. Particles can be guided at least 10 times farther with fibers than without (under comparable conditions including laser power, beam waste, and wavelength). Again, the main reason is that Gaussian beams diverge rapidly compared to guided fiber modes. Consequently the gradient guiding forces diminish over shorter distances. The cited art (Ashkin, Nishimura) teaches particle guidance only with Gaussian beams.

Regarding the other art cited by the examiner, Richart teaches a method for fabricating microscopic particles, not a way to manipulate them. Kindler teaches a method of coating surfaces by using a laser beam to melt particles just before they are deposited. Kindler does not teach methods for guiding the particles, only methods for melting them before deposition. Kindler cannot achieve high-resolution patterning with the method disclosed therein.

Being filed herewith is a Petition for Extension of Time to October 6, 2003 with the appropriate fee. Authorization is given to charge payment of any additional fees required, or credit any overpayment, to Deposit Acct. 13-4213. A duplicate of this paper is enclosed for accounting purposes.

An earnest attempt has been made to respond to each and every ground of rejection advanced by the Examiner. However, should the Examiner have any queries, suggestions or comments relating to a speedy disposition of the application, the Examiner is invited to call the undersigned.

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Being filed herewith is a Petition for Extension of Time to September 8, 2003, the first business day following September 6, 2003, with the appropriate fee. Authorization is given to charge payment of any additional fees required, or credit any overpayment, to Deposit Acct. 13-4213. A duplicate of this paper is enclosed for accounting purposes.

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Reconsideration and allowance are respectfully requested.

Respectfully submitted,

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